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REVIEW OF THE GASTERUPTIIDAE (HYMENOPTERA) OF EASTERN NORTH AMERICA

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Abstract.—Five species of Gasteruptiidae are known in eastern North America. Known hosts are bees and wasps nesting in wood or twigs. A key is given for their identification, and distributions and known hosts are reviewed. Seasonal activity is presented based on collections from the mid-Atlantic United States. The peak flights are from May to July, but adults are present from the end of April into October.

Key Words: Gasteruptiidae, eastern North America, key, hosts, seasonal occurrence

Species of Gasteruptiidae (also in some literature as Gasteruptionidae) are parasitoids in the nests of Apoidea, Sphecoidea, and possibly Vespoidea, which nest in wood or in twigs. Few hosts are known, and little is known of the biology of Gasteruptiidae in North America. Adults are commonly found on flowers, especially Apiaceae (= Umbelliferae), or in flight while exploring around stumps, logs, or posts. Townes (1950) treated 15 North American species, five of which he further divided into two or more subspecies, and recognized two genera, *Gasteruption* Latreille and *Rhydinofoenus* Bradley. Crosskey (1962) recognized six genera in his study of the world fauna. He separated five small genera that occur in the Neotropical and Australian regions, but he could not satisfactorily divide the large, worldwide genus *Gasteruption* into smaller units. Therefore, all North American species are currently placed in *Gasteruption.*

Five species occur in eastern North America. I collected four species including large series of three of them while Malaise trapping in the mid-Atlantic states over the past 13 years. Based on collections of 946 specimens, the following review is presented, including updated information on hosts, distributions, and seasonal activity.

Townes (1950) based subspecies of *G. assectator* (L.), *G. kirbii* (Westwood), *G. tarsatorium* (Say), and *G. floridanum* (Bradley) on color differences. Carlson (1979) did not recognize subspecies for *G. assectator.* I have not recognized subspecies; however, for reference, I mention previous usage in the species introductions. Users may refer to Townes (1950) for more details if they prefer to use subspecific names.

Materials and Methods

Collections were by Townes-style Malaise traps (Townes 1972) using 95% ethyl alcohol as a killing agent in most traps and potassium cyanide only in those at Green Ridge State Park, Maryland. Traps were in continuous operation from March or April through October or November each year, depending on the site, and serviced every ten days to two or three weeks, depending on the weather and time of year. Collection

sites are as follows, with years of trapping and number of traps used at each site: MARYLAND: Beltsville Agricultural Research Center, 2–6 mi W Beltsville, Prince George's Co. (1991–1993, 3–4 traps); Finzel Swamp, 1 km S Finzel, Garrett Co. (1992–1993, 2 traps); Green Ridge State Park, 6 mi E Flintstone, Allegany Co. (1991–1993, 6 traps). VIRGINIA: Fairfax Co., nr Annandale (1981–1994, 1 backyard trap); Essex Co., 1 mi SE Dunnsville (1991–1994, 12–16 traps); Clarke Co., University of Virginia Blandy Experimental Farm and State Arboretum of Virginia, 2 mi S Boyce (1990–1994, 5–13 traps); Louisa Co., 4 mi S Cuckoo (1985–1989, 1–12 traps). WEST VIRGINIA: Tucker Co., Fernow Experimental Forest, south of Parsons (1991–1993, 20–24 traps); Hardy Co., 3 mi NE Mathias (1994, 2 traps). Although the number of traps at a given site sometimes varied from year to year, the number of traps used for each season was the same for the entire collecting period.

In the "specimens examined" sections, references to these sites are by state and county, and years of collection are given only when one or a few specimens were collected. Specimens are deposited in the National Museum of Natural History, Washington, D.C.

For references to original descriptions and synonymy, see Townes (1950) and Carlson (1979). Records in the distribution sections are from Townes (1950) and specimens in the National Museum of Natural History. Records in the specimens examined sections are from my collections.

Key to Species

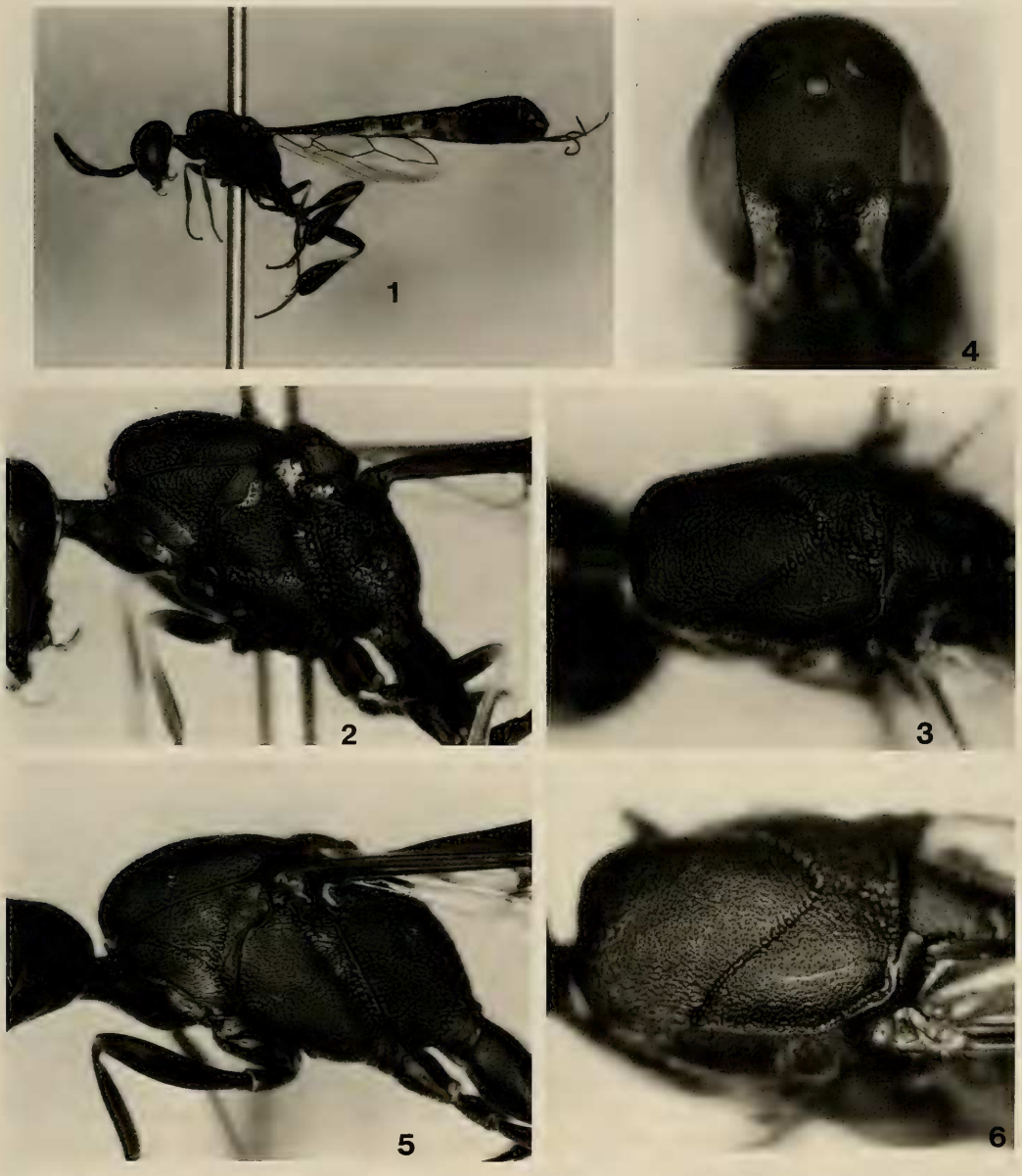
1. Ovipositor sheath ⅓ to ½× forewing length (Fig. 1); female subgenital plate with broad V-shaped notch; pronotal tooth blunt or obsolete; texture of head dull, granulose (Fig. 4); hindtarsus rarely marked with white (tegula black) 2
– Ovipositor sheath 2 to 2 ½× forewing length (similar to Fig. 9); female subgenital plate with narrow, deep, slit-shaped notch; pronotal tooth usually distinct and acute (as in Fig. 10); head shining (Fig. 12); hindtarsus often marked with white 3
2. Sculpturation on side of thorax, especially lower mesopleuron, metapleuron, and propodeum, relatively coarse; mesonotum with somewhat more evident transverse striation (Figs. 2, 3) . . . . . *.assectator* (Linnaeus)
– Sculpturation on side of thorax and propodeum finer and more granular in appearance; mesonotum with finer punctures and less conspicuous striation (Figs. 5, 6) . . . . . *kirbii* (Westwood)
3. Tegula black; mesonotal lateral lobes with weak, medium to small punctures (Fig. 8) (fore- and midtibiae whitish at base, rest brown or reddish). . . . . *barnstoni* (Westwood)
– Tegula light orange to reddish brown; mesonotal lateral lobes often with some large, strong punctures (Figs. 11, 14) 4
4. Fore- and midtibiae reddish brown, somewhat paler basally; propleuron with some rather coarse transverse wrinkles (Fig. 10); side of thorax with shiny interspaces between punctures, not densely hairy (Fig. 10); pronotum black . . . . . *floridanum* (Bradley)
– Fore- and midtibiae with an external white stripe from base to apex, or white basally and apically with white areas elongate externally; propleuron without coarse transverse wrinkles (Fig. 13); texture of side of thorax dull between punctures, hairs dense (Fig. 13); posterior corner of pronotum usually with dull-orange spot . . . . . *tarsatorium* (Say)

Gasteruption assectator (Linnaeus) (Figs. 1–4, 15)

This is a holarctic species. Townes (1950) recognized several subspecies in North America. The common one in the East was under the name *G. assectator arca* (Couper). Carlson (1979) did not recognize subspecies.

Diagnosis.—Ovipositor sheath ⅓ to ½ of forewing length; female subgenital plate with broad V-shaped notch; pronotal tooth blunt to obsolete; head texture dull and granulose; tegula black; thorax with relatively coarse sculpturation (compare Figs. 2 and 3 with Figs. 5 and 6 for separation from *kirbii*).

Distribution.—Nova Scotia to Alaska south to North Carolina, Kansas, Arizona, and California; Eurasia. Eastern North America: Connecticut, Illinois, Indiana,



Figs. 1–6. 1–4, *Gasteruption assectator.,* female 1, Lateral view. 2, Lateral view of thorax. 3, Dorsolateral view of thorax. 4, Front view of head. Length, ca. 10 mm, without ovipositor. 5–6, *Gasteruption kirbii,* female. 5, Lateral view of thorax. 6, Dorsolateral view of thorax. Length, ca. 10 mm, without ovipositor.

Iowa, Kansas, Maine, Manitoba, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Newfoundland, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Nova Scotia, Ohio, Ontario, Pennsylvania, Quebec, Rhode Island, South Dakota, Vermont, Virginia, West Virginia, Wisconsin.

Specimens examined.—Total: 260. MARYLAND: Garrett Co. 21–30.V to 28.IX–15.X (77); Prince George's Co. 3–15.V to 30.V–12.VI (6). VIRGINIA:

Figs. 7–8. *Gasteruption barnstoni,* female. 7, Lateral view of thorax. 8, Dorsolateral view of thorax. Length, ca. 14 mm, without ovipositor.

Clarke Co. 28.IV–10.V to 21.VII–5.VIII (105); Essex Co. 22.IV–3.V to 1–10.VI (24); Fairfax Co. 28.IV–5.V to 30.VII–5.VIII (30); Louisa Co. 1–12.V to 8–19.VI (9). WEST VIRGINIA: Hardy Co., 15.V–10.VI.1994 (3); Tucker Co. 21–30.V to 20–29.VII (6).

Hosts.—Reared from *Carya glabra* (Mill.) Sweet in New York, from climbing bittersweet in Pennsylvania, from pemphredonine (Sphecidae) in a rose stem in Ohio, and from cocoon under bark in Ontario (Townes 1950). Carlson (1979) gave *Hylaeus ellipticus* (Kirby) (Colletidae) and *Megachile rotundata* (F.) (= *M. centuncularis* (L.)) (Megachilidae) as hosts. Treherne (1916), cited the hosts of *Foenus incertus* Cresson (a synonym of *G. assectator*), as "bees." Further associations from labels on specimens from various localities, mostly representing adult collection data, include: from wild carrot; from flowers of *Aruncus aruncus* L.; on dead oak tree; reared from sumac stem; on *Hydrangea arborescens* L.; *Pinus murryana* Balf. (= *Pinus contorta* Dougl.); swept goldenrod; and ex gall of "*Rhodites tuberculator*" (= *Diplolepis tuberculatrix* (Cockerell) (Cynipidae)). Höppner (1904) reported on the biology in Europe, with the host as *Prosopis* spp. (now treated as a subgenus of *Hylaeus*).

Discussion.—*Gasteruption assectator* is very close to *G. kirbii,* and the two are very difficult to separate. So far as I can tell, all specimens I have collected as cited in the specimens examined section are *G. assectator.*

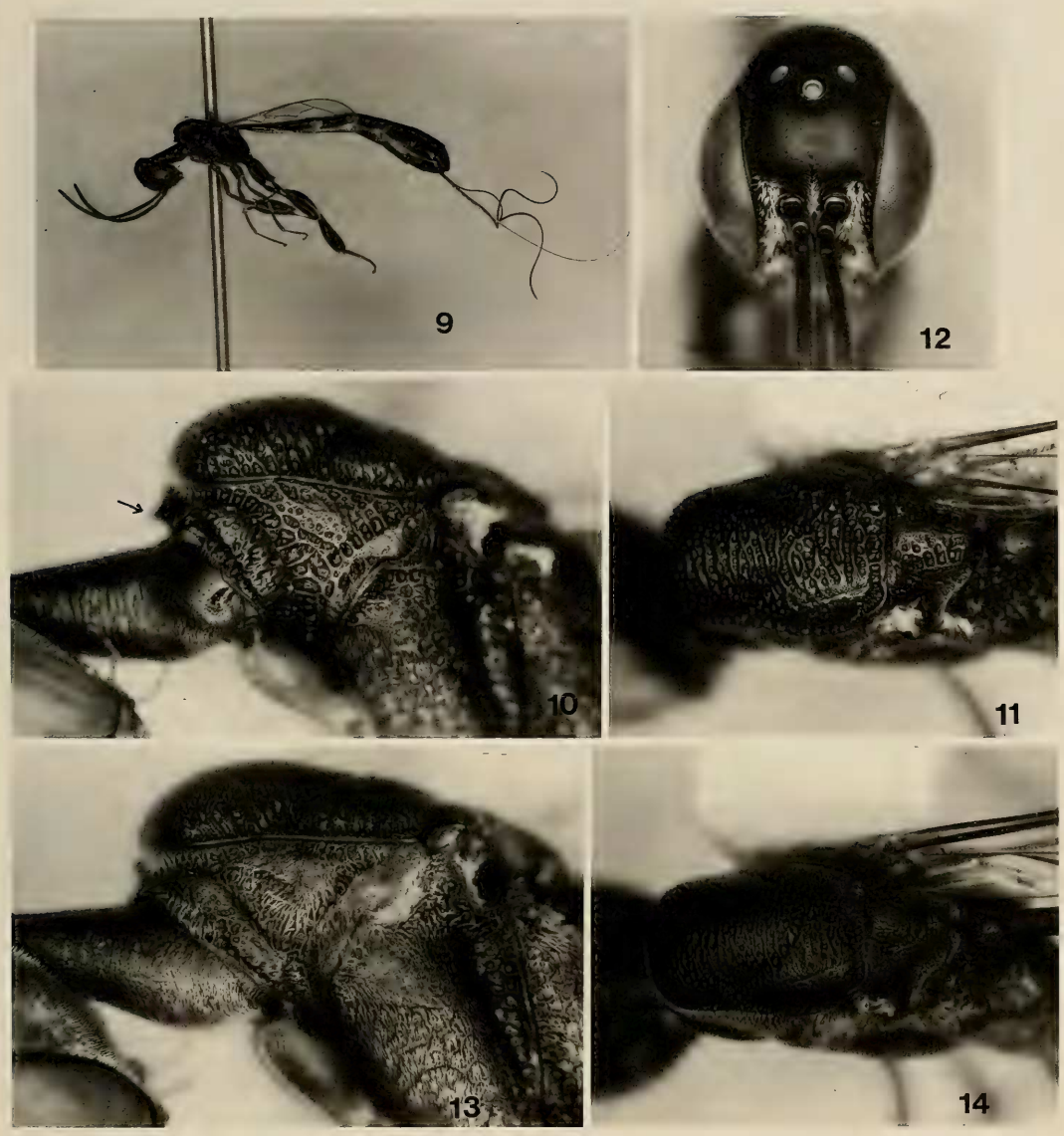
According to Townes (1950) collection dates for most specimens are from May 30 to September 10, with April 26 the earliest record and September 15 the latest record. I have found the first specimens of the season in late April, and the species is present through the first third of October (Fig. 15). There is a peak from mid-May through mid-June, but populations appear to be rather steady from May through July, with lower populations in August and September.

Gasteruption barnstoni (Westwood)
(Figs. 7, 8)

Townes recognized the typical subspecies from eastern North America to western Canada and one other subspecies, *G. b. perplexus* (Cresson) from the Rocky Mountains westward. The two subspecies were separated by color and slight sculpture differences on top of the head. Carlson (1979) indicated that these may not be meaningful subspecies.

Diagnosis.—Ovipositor sheath more than 2× forewing length; tegula black; mesonotal lateral lobe with weak, medium to small punctures; fore- and midtibiae whitish at base, remainder brown to reddish.

Distribution.—Eastern Canada and United States to Alaska, south to Virginia, Ohio,



Figs. 9–14. 9–11, *Gasteruption floridanum,* female. 9, Lateral view. 10, Lateral view of thorax; arrow points to pronotal tooth on right side of thorax. 11, Dorsolateral view of thorax. Length, ca. 14 mm, without ovipositor. 12–14, *Gasteruption tarsatorium,* female. 12, Front view of head. 13, Lateral view of thorax. 14, Dorsolateral view of thorax. Length, ca. 14 mm, without ovipositor.

Illinois, New Mexico, Arizona, California. Eastern North America: Alberta, Connecticut, Illinois, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Brunswick, New Hampshire, New York, Nova Scotia, Ohio, Ontario, Pennsylvania, Prince Edward Island, Quebec, Saskatchewan, Vermont, Virginia, West Virginia.

Specimens examined.—Total: 13. MARYLAND: Garrett Co. 20–29.VI to 8–17.IX (10). VIRGINIA: Essex Co., 22.IV–17.V.1994 (3).

Hosts.—Unknown.

Discussion.—According to Townes (1950) most collection records are from June 20 to August 10, with June 5 the ear-

liest record and September 22 the latest record. This is a more northern species, and I have found only a few specimens at Finzel Swamp, Garrett Co., Maryland, and in Essex Co., Virginia. The Maryland, West Virginia (Bolivar, Jefferson Co.), and Virginia records are the southernmost in eastern North America for this species.

Gasteruption floridanum (Bradley)
(Figs. 9–11, 16)

Townes (1950) recognized the typical subspecies from North Carolina, Georgia, Florida, and Cuba and *G. floridanum bradleyi* Townes over the rest of its range. They were separated by color, the more southern subspecies with the thorax largely reddish and the wings slightly darker.

Diagnosis.—Ovipositor sheath about 2× forewing length; tegula light reddish; mesonotal lateral lobes with some large, strong punctures; fore- and midtibiae somewhat whitish basally, remainder reddish; propleuron with rather coarse transverse wrinkles; thorax with shiny interspaces between ridges and punctures, hairs usually present but not so dense as to obscure surface; pronotum black.

Distribution.—Eastern North America: Connecticut, Delaware, District of Columbia, Florida, Georgia, Illinois, Kansas, Maine, Maryland, Massachusetts, Missouri, Mississippi, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Ontario, Pennsylvania, Rhode Island, Texas, Virginia, Wisconsin.

Specimens examined.—Total: 248. MARYLAND: Allegany Co. 1–10.VII (1); Garrett Co. 30.VI–9.VII to 30.VII–9.VIII (3). VIRGINIA: Clarke Co. 10–21.V to 29.IX–22.X (149); Essex Co. 12–29.IV to 17.IX–10.X (71); Fairfax Co. 5–11.VI and 8–19.VII (2); Louisa Co. 24.IV–4.V to 12.IX–6.X (22).

Hosts.—Walkley (1967) gave two host records, *Hylaeus cressoni* (Cockerell) (Colletidae) and *Trypoxylon frigidum* Smith (Sphecidae), but Carlson (1979) did not give host records as he found no specimens bearing such host data and stated that he had reason to doubt the identity of the parasites. I was also unable to find such records. However, Hurd (1979) listed *G. floridanum* as a parasite of *Hylaeus mesillae cressoni,* probably based on Walkley's record. According to specimen labels, adults have been collected from flowers of *Cicuta maculata* L.; flowers of *Ceanothus americanus* L.; wildflowers; *Daucus carota* L.; from *Polygonum*; and from *Polygonum hydropiperoides* Michx.

Discussion.—Townes (1950) indicated that most specimens were collected in June, July, and August, with the earliest record of March 19 and latest record of October 18. I have collected this species from the end of April through the first third of October (Fig. 16). The peak flight period is mid-May through the first third of June and populations appear to be high through mid-July. Populations are lowest from the end of July through the rest of the season.

Gasteruption kirbii (Westwood)
(Figs. 5, 6)

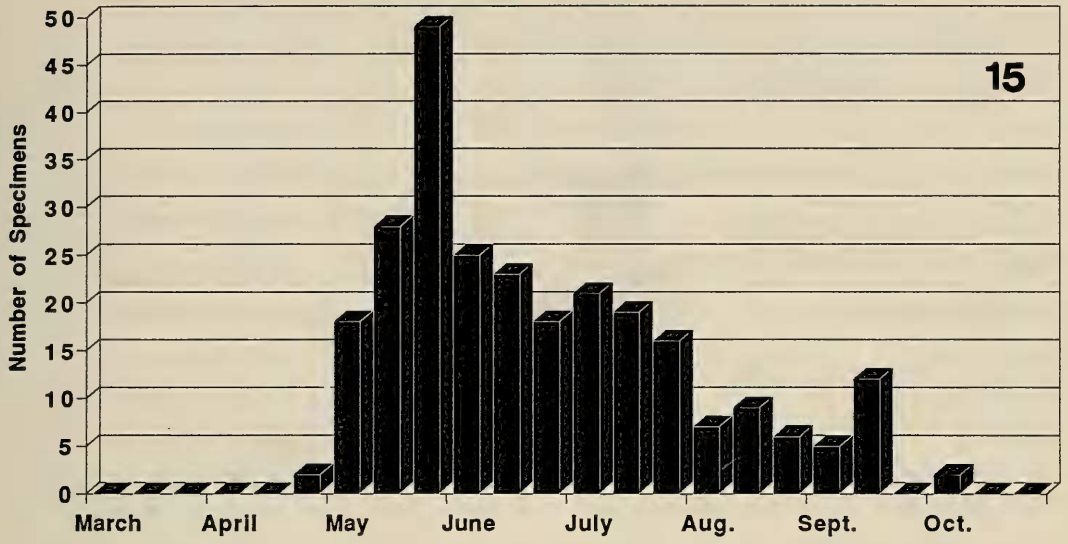
Townes (1950) separated two subspecies, the typical subspecies from northeastern United States and eastern Canada west to British Columbia, and *G. kirbii russeus* Townes from the Rocky Mountains west to the Pacific. The two were separated by the amount of orange on the abdomen, with *G. k. russeus* having the abdomen largely orange.

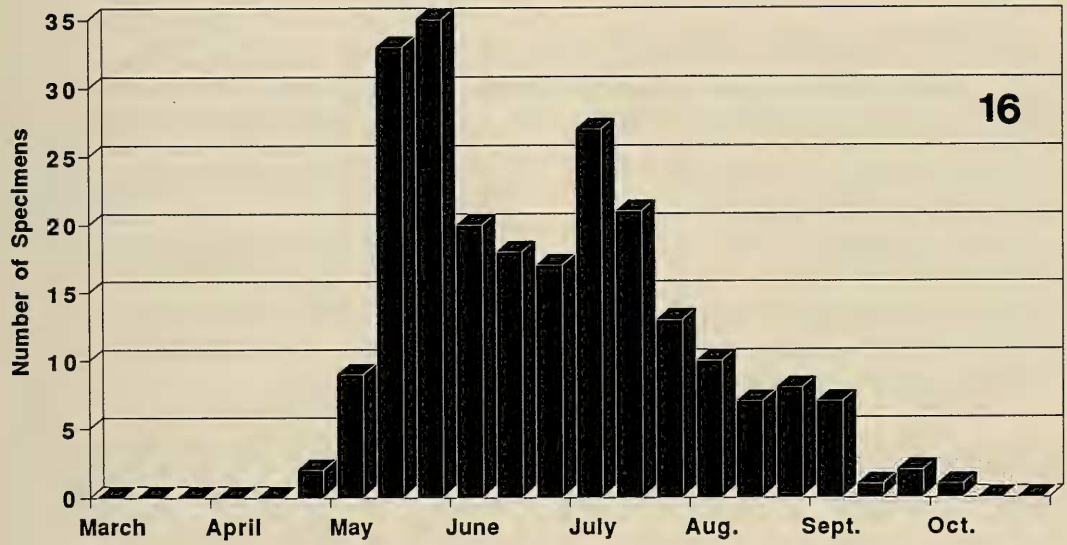
Diagnosis.—Very similar to *G. assectator* except for finer, more granular texture of the thorax (compare Figs. 5 and 6 with Fig. 2 and 3).

Distribution.—Nova Scotia to British Columbia, south to New York, Michigan, Colorado, California. Eastern North America: Michigan, New Brunswick, New York, Nova Scotia, Ontario, Prince Edward Island, Quebec, Saskatchewan.

Specimens examined.—None.

Hosts.—*Hylaeus modestus* Say (Colletidae), *Hoplitus sambuci* Titus (Megachilidae), and *Megachile rotundata* (F.) (= *M.*





Figs. 15–16. Seasonal occurrence. 15, *Gasteruption assectator.* 16, *G. floridanum.*

centuncularis (L.)) (Megachilidae) (Carlson, 1979).

Gasteruption tarsatorium (Say)
(Figs. 12–14, 17)

Townes (1950) recognized the typical subspecies from most of eastern North America and one other subspecies, *G. t. solaris* Townes, from Arizona and Kansas. *Gasteruption t. tarsatorium* is characterized by the presence of a pale spot at the hind corner of the pronotum and one on the underside of the scape, both of which are lacking in *G. t. solaris.*

Diagnosis.—Ovipositor sheath about to slightly more than 2× forewing length; tegula light reddish; mesonotal lateral lobe with some large, strong punctures; fore- and midtibiae with external white stripe from base to apex, or white basally and apically

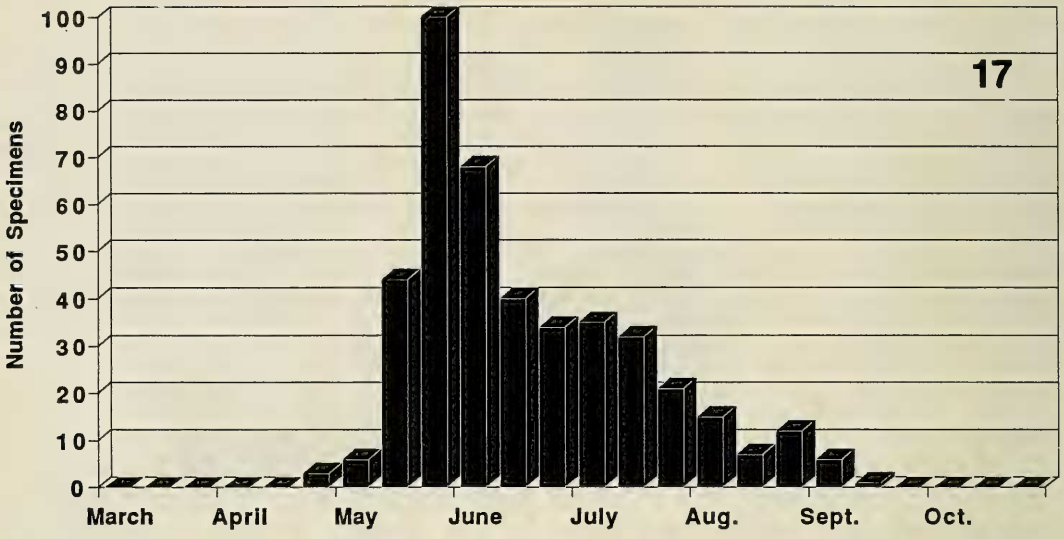


Fig. 17. Seasonal occurrence of *Gasteruption tarsatorium.*

with white areas elongate externally; propleuron without coarse transverse wrinkles; side of thorax finely punctate and dull between punctures and sculpture, densely hairy; posterior corner of pronotum and under side of scape commonly with dull-orange spot (males often black or with pale marks indistinct).

Distribution.—Arizona. Eastern North America: Connecticut, District of Columbia, Indiana, Iowa, Kentucky, Maine, Maryland, Massachusetts, Michigan, Missouri, Nebraska, New York, North Carolina, New Hampshire, New Jersey, Ohio, Ontario, Pennsylvania, Quebec, South Carolina, Tennessee, Virginia.

Specimens examined.—Total: 425. MARYLAND: Allegany Co. 31.V–10.VI to 30.VII–8.VIII (9); Garrett Co. 10–19.VII and 29.VIII–7.IX (2); Prince George's Co. 5–18.V to 11–24.VII (29). VIRGINIA: Clarke Co. 26.IV–9.V to 26.VIII–11.IX (278); Essex Co. 22.IV–3.V to 17.IX–10.X (49); Fairfax Co. 6–12.V to 23–29.VII (10); Louisa Co. 1–11.V to 13–27.VII (48).

Host.—Reared from "climbing bittersweet" in Pennsylvania (Townes 1950). Rau (1922, 1928a) published two host records from Missouri. One specimen (Rau, 1922) was obtained from an elder twig at Meramec Highlands; other twigs in the same lot contained *Hypocrabro stirpicolus* (= *Ectemnius stirpicola* (Packard)) (Sphecidae), and he inferred that the wasp was its host. The other (Rau, 1928a) emerged from the nest of *Stenodynerus zendaloides* Robertson (= *Leptochilus ornatus* Saussure) (Vespidae). The latter is probably correct since there is one specimen of *G. tarsatorium* in the National Museum of Natural History labeled "Phil Rau, Rau no. 4439, St. Louis, Mo." and in the reprint of Rau's 1928a article is a handwritten note "Rau No. 4439 in USNM." The specimen and host from the elder twig can not be verified. Treherne (1916) recorded the host as "bees." Rau (1928b) recorded it from a nest of *Ceratina calcarata* Robertson (Anthophoridae). Krombein (1979) recorded *G. tarsatorium* as a parasite of *Leptochilus ornatus,* and Hurd (1979) listed *G. tarsatorium* as a parasite of *Ceratina calcarata,* both probably taken from Rau's publications.

According to data on specimen labels, adults have been collected from the following: flowers of *Rhus glabra* L.; on *Ceanothus americanus* L.; *Daucus carota* L.; and

Aruncus aruncus L. A specimen from Nebraska is labeled "ex gall on *Amorpha fruticosa.*"

Discussion.—Townes (1950) gave most records in July and August, with an early record of June 3 and late record of September 18. I have collected this species from the end of April through the first third of September (Fig. 17). The peak flight period is mid-May through the first third of June, and numbers drop off sharply beginning the end of July.

There are occasional reddish forms that appear in collections. These may have all or parts of the mesonotum, mesoscutellum, pronotum, and lower mesopleuron reddish, or various combinations or amounts of reddish. From collections of 425 specimens only 6 had some significant amounts of reddish on the thorax.

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